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ABSTRACT

An anonymous 12-item, multiple-choice questionnaire was administered to 218 southern college, introductory zoology students prior to and following a study of evolutionary theory to assess their understanding and acceptance of the credibility of the evidence supporting the theory. Key topics addressed were the history of evolutionary thought, basic Darwinism, natural selection, speciation, macro and micro evolution and evolutionary trends. All students followed the same course outline and identical laboratory investigations. Findings indicate internal student conflict between personal beliefs and values and ideas presented in the zoology courses. A number of misconceptions that students hold about evolutionary theory were identified. The students were also asked to explain whether or not their religious views were reconcilable with the evolutionary theory taught. Their beliefs were shown to interfere with their ability to view scientific evidence objectively, especially when they involved deeply ingrained religious teachings that were counter to the information being presented. All the students who rejected evolutionary theory gave as their reason opposing religious views. Those who held strong creationist religious beliefs felt the choice was dichotomous; they accepted a literal Biblical account of creation and rejected the evidence supporting the theory of evolution. (Contains 11 references.) (NAV)

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Running head: RELIGIOUS BELIEFS AND EVOLUTIONARY THEORY

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The Relationship between College Zoology-Students' Religious Beliefs and Their Ability to Objectively View the Scientific Evidence Supporting Evolutionary Theory

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Abstract

An anonymous questionnaire was administered to college zoology students prior to and following a study of evolutionary theory to assess their understanding and acceptance of the credibility of the evidences supporting the theory. A number of misconceptions that students held about the theory were identified. The students were also asked to explain whether or not their religious views were reconcilable with this theory. Their beliefs were shown to interfere with their ability to objectively view scientific evidence, especially when they involved deeply ingrained religious teachings which were counter to the information being presented. All of the students who rejected evolutionary theory gave as their reason opposing religious views. Those who held strong creationist religious beliefs felt the choice was dichotomous. They accepted a literal Biblical account of creation and rejected the evidence supporting the theory of evolution.

The Relationship between College Zoology Students' Religious Beliefs and Their Ability to Objectively View the Scientific Evidence Supporting Evolutionary Theory

Students often bring with them to biology classes, both at the secondary and college levels, religious biases and misconceptions which prevent them from objectively viewing the scientific evidences supporting evolutionary theory (Edlin, 1987; Sinclair & Baldwin, 1995). Scharmann (1993) found that high school biology teachers perceive the instruction of evolutionary theory to be one of the more troublesome content areas. Secondary biology instructors have sometimes been ineffective in "widening the world view" of their students because the topic has been treated superficially in order to avoid controversy with religious conservatives who support the teaching of creationism, often to the exclusion of evolutionary theory.

As a result, college biology students are unprepared both emotionally and academically when confronted with the more rigorous curriculum. They believe there is a forced "either/or" choice between their religious faith and evolutionary theory. Undue pressure is brought to bear on these students because of the seemingly forced dichotomy which requires that one reject the theory of evolution and accept a literal interpretation of the Biblical account of creation. Certainly not all religious faiths insist upon this dichotomous choice. Scott and Cole (1985) observed, "Christian religions, not based upon Biblical literalism, long ago made peace with evolution" (p. 28).

Lawson & Weser (1990) found that religious beliefs which were counter to scientifically accepted theories were difficult to alter and many students did not have the reasoning skills needed to comprehend the complex evidences and arguments presented by evolutionary theorists. In a study conducted by Lawson and Worsnop (1992), it was also shown that levels of thinking affected the ability to reconcile

differences in belief systems. The researchers found that students who reason at the intuitive and concrete levels were more likely to retain nonscientific beliefs because of their low tolerance to ambiguity. One of the most threatening ambiguities is that even though evolutionary theory withstands rigorous scrutiny and presently offers the best explanation for the diversity of life, there are areas of controversy among respected evolutionary biologists. It is important for students to realize that these disagreements are not about the basic conceptual framework of evolutionary theory, but concern specific processes of change. Dobshansky (1973) stated, "Nothing in biology makes sense except in the light of evolution" (p. 129). Sharmann (1993) would agree, for he contended that evolution is the most significant unifying them in biology because it explains the diversity of living organisms.

Lawson and Worsnop (1992) purport that the intent of instruction should not be to change the students' minds, but should be to present the evidences which support evolutionary theory in such a way as to provoke students to explore the alternatives and to utilize deductive reasoning as they reflect and weigh the strengths and weakness of the various scientific and religious arguments. Edlin (1987) found that college biology students who held creationist views were able to more objectively view the evidence when instructed using a genetical and molecular approach rather than a paleontological one. The researcher concluded that these evidences were more compelling than those from fossils.

Studies have confirmed that the teaching of evolutionary theory, both at the secondary and college levels, is complex because of the multiple dynamics operating. The unquestioned difficulty of the content, compounded by the religious biases and scientific misconceptions brought to the classroom by many of the students, make the instructional process challenging (Edlin, 1987; Lawson & Weser, 1990; Lawson & Worsnop, 1992; Nelson, 1986; Sharmann, 1993; Sinclair & Baldwin, 1995).

Purpose of the Study

The purposes of this study were twofold. The first was to determine the relationship between college biology students' religious beliefs and their ability to objectively view and comprehend the often complex evidence which supports evolutionary theory. It was hypothesized that those who held less conservative religious beliefs would more likely accept the credibility of the theory's explanations. This hypothesis is consistent with the research findings of Lawson and Worsnop (1992). The second purpose was to add to the existing body of knowledge concerning commonly held biases and misconceptions about the theory of evolution before and after a thorough coverage of the supporting evidences. By identifying specific areas of misunderstanding and bias, instructional strategies targeting these areas of difficulty will be recommended for testing.

Data Collection and Analysis

Data were collected from 218 students taking introductory college zoology at a southern regional university. Five professors and their classes participated in the study during the spring of 1995. Sixty nine percent of the students were females. Ninety one percent were white, 6.5% were black, 1.4% were Asian, and .5% were Hispanic. Most of the students came from either rural (40.7%) or suburban (41.6%) hometowns. Of those participating, 57.5% had declared science or science related majors (e.g., nursing).

The key topics addressed were the history of evolutionary thought, basic premises of Darwin's theory of evolution, the mechanisms of natural selection, speciation, evidences from macro and micro evolution, and evolutionary trends. To insure that all students in the study received similar instruction, the professors followed the same content outline and the students experienced identical laboratory investigations.

Pre and posttests were administered to each of the students prior to and following instruction on evolutionary theory. The anonymous inventory consisted of 12 multiple choice questions which targeted their understanding and acceptance of the theory of evolution. Two of the questions asked the students to describe the reasons for their beliefs. The pre and posttests were identical, except the latter had two additional questions. The first asked the students to explain whether the study had resulted in changes in their thinking about evolutionary theory and the last question pertained to any recommendations they could give to the professors which would have assisted them in gaining a better understanding of the theory.

Results

Descriptive statistics were calculated for all of the multiple choice items. Differences in response patterns for the pre and posttests were analyzed using the Chi Square test for statistical significance. Qualitative data taken from the narrative responses were summarized to identify commonly occurring as well as relevant and noteworthy comments.

Understanding of Scientific Theory and the Theory of Evolution

Descriptive statistics are reported in Table 1 for questions which pertain to their understanding of scientific theory, and more specifically, to the theory of evolution. On both the pre and posttests, approximately two-thirds of the students selected the correct definition for a theory (question 1) and nearly 90% on both measures were able to identify the best description of the theory of evolution (question 2). Though such a large percentage selected the appropriate response, only 18.0% on the pretest and 28.1% on the posttest correctly identified the primary mechanism that results in change of species over time (question 3). Most of the students (63.3% on the pre and 65% on the posttest) chose incorrect responses which contained Lamarkian explanations. Clearly, the majority did not comprehend the mechanisms of speciation.

Insert Table 1 about here

Significant changes occurred between the pre and posttest (21.2% vs. 33.9%, respectively, selected the correct choice) concerning the students' comprehension of Darwin's theory of survival of the fittest (question 4), although, nearly two-thirds of the students chose incorrect descriptions. Significant changes were also found between the two measures regarding Darwin's theory of natural selection (49.8% on the pre and 78.3% on the posttest chose the correct response - question 5).

Strongest and Weakest Evidences of Evolutionary Theory

Significant changes did not occur between the pre and posttest regarding which of the scientific evidences of evolutionary theory students felt were the strongest (Table 2-question 6). On both the pre and posttests, fossils (29.0% vs. 35.5%, respectively) and variations of extant species (13.4% vs. 22.1%, respectively) were most often selected. Only small percentages of students selected the more complex evidences on the posttest such as biochemical (3.2%), genetic (7.4%) or embryological similarities (5.5%), even though these topics were given equal coverage during instruction. Concerning what the students perceived to be the weakest evidences offered by scientists supporting the theory of evolution (question 7), most of the their choices centered around whether life originated from a simple type of cell (28.8% on the pre and 37.0% on the posttest) and whether complex organisms such as humans evolved from simpler species (22.3% on the pretest vs. 16.7% on the posttest). Significant changes occurred between the two measures on each of these responses. A consistent finding was that approximately 25% of the students on both the pre and posttests felt that none of the arguments presented by biologists were weak.

Insert Table 2 about here

Religion and Evolutionary Theory

Less than 20% of the students (12.5% on the pretest vs. 19.9% on the posttest) felt there was no disagreement between their religious beliefs and the theory of evolution (Table 3 - question 8). Significant changes occurred between the two measures regarding whether the students felt they were in disagreement. On the pretest, 45.6% felt that their religious beliefs were in conflict with the theory, while on the posttest this percentage dropped to 29.6%. Despite this change, 34.3% of the students on the posttest expressed there was some disagreement between the two and 16.2% were not sure.

No changes occurred between the pre and posttest regarding whether the students felt one could accept the validity of the theory of evolution and also believe in God (question 9). On both measures, 74% of the students felt that it was possible to reconcile these beliefs. One quote epitomizes many of the responses: "Yes, evolution and belief in God can coexist. We can't ignore factual evidence." Another said, "Evolution is part of God's ultimate plan. Evolution explains a lot more intelligently and specifically where we originated." "Science is based on fact; religion is based on faith. God used evolution during creation and we are slowly finding out how He did it," wrote another student. An additional comment was, "If a person believes that a supernatural being put this system in motion, who is anyone else to argue? Science deals in facts, not the supernatural."

Twenty six percent of the students surveyed on both measures felt that the two concepts were not reconcilable. One student in this group wrote, " I feel that if you believe in Adam and Eve and the Bible, you can never believe in evolution."

Insert Table 3 about here

When asked whether they had specific concerns about evolutionary theory, significant changes occurred between the pre and posttests (question 10). While 35% of the students identified specific areas that troubled them on the pretest, only 25% did so on the posttest. Of the students who responded in the affirmative, most of their concerns on both measures centered around the origin of life and humans evolving from lower primates. One stated, "I am okay with animals evolving but not with man coming from another animal. I do not like to think of the human race as a monkey." "The first cell had to come from somewhere. God has to fit in someplace," commented another. "People assume it [evolutionary theory] is a proven law and not a theory which leads to gross generalizations. People assume it explains much more than it actually does. Evolution doesn't give any place to religious beliefs but uses terms like 'stumbled' and 'random'," was another observation made.

Changes in Thinking

When asked what influenced them the most when presented with new scientific ideas, a majority of the students (68.4% on the pre and 74.8% on the posttest) indicated that sound, objective evidence was the most convincing (Table 4 - question 11). Only 38.5% of the students surveyed indicated on the pretest that they were very open-minded to new scientific ideas (question 12), yet on the posttest, 77.6% felt they had changed their thinking about the theory of evolution (question 13). A representative comment made was, "It has made me realize that the purpose of evolution is not that we came from monkeys, but that we simply change over long periods of time. Studying science does not disprove my faith, it only strengthens it. I have come to realize that someone could accept both points of view and still believe in God."

Insert Table 4 about here

Of the 22.4% who indicated that their thinking had not changed, only three students stated that they had accepted and understood evolutionary theory prior to the study. The rest of the comments indicated that their religious beliefs would not allow them to accept the evidence supporting evolutionary theory. Cited below are representative statements made by those who felt that evolutionary theory and religion were at odds:

"I was not given enough proof of research to change my thinking. Not enough evidence was shown to make me 100% sure."

"My religion is not believing in science but in God."

"It [evolutionary theory] totally conflicts with my religious beliefs."

"It [evolutionary theory] completely disagrees with the Bible and forces people to choose sides."

Recommendations for Biology Professors

The students were asked to identify ways their biology professors could have assisted them in better understanding the theory of evolution (see question 14). Nearly eighty four percent of the students offered no suggestions. The few who did respond (16.1%) gave the following recommendations. One felt that more time should be given to the topic. Another suggested that more detail should be given describing how species change over time. All of the other comments recommended that creationism be discussed along with evolutionary theory.

Discussion

This study was descriptive in nature, yet the findings can serve as an impetus for additional research. From the results of this study, as well as others (Lawson & Worsnop, 1992; Scharmann, 1990; Sinclair & Baldwin, 1995), we can conclude that students' beliefs interfere with their ability to objectively view scientific evidence, especially when they involve deeply ingrained religious teachings which are counter to the information being presented. Our hypothesis that those who held less conservative religious beliefs would more likely accept the credibility of evolutionary theory was strongly supported. All of the students who rejected the credibility of evolutionary theory gave as their reason opposing conservative religious views.

Another objective was to identify misconceptions held about evolutionary theory. Many did not have an understanding of the complexities of the theory. Only two-thirds of the students selected the correct definition of a theory. One recommendation for biology professors is to clearly define this term. Perhaps the reason many do not comprehend evolutionary theory is because they do not have an understanding of the essence of its meaning. A preponderance of evidence supports it, yet it does not reach the level of a proven law, neither is it a hypothesis with limited evidential support.

Nearly half of the students believed that organisms can adapt in order to survive and no differences occurred between the pre and posttests. For whatever reason, the students displayed a lack of understanding of the mechanisms of evolution by believing that living species could, with personal effort and resolve, adapt to changing conditions. Additionally, two-thirds of the students failed to understand Darwin's Theory of Natural Selection. It would appear that students often find the global tenets of the theory difficult to comprehend. Even though the theories of primate evolution were clearly addressed citing specific paleontological, biochemical and genetical evidences, the

students tenaciously held to misconceptions and religious biases regarding ancestral relationships between humans and other primates.

The results of this study have shown that beliefs and values of many students can be in conflict with the ideas being presented in zoology courses. Nichols (1995) stated that "how" we teach is often as important as "what" we teach. "Science is not just information; it is the expression of that information, and expression is seldom value-neutral" (p. 271). A recommendation to biology instructors is to take the religious beliefs of students seriously. They should be allowed to express their concerns and questions without fear of rejection or censure. The classroom should not become confrontational nor adversarial. It should be made clear from the beginning, though, that all claims will be held up to the light of scientific scrutiny. The central focus must be insistence upon scientific evidence. This is required if one is to become scientifically literate.

Scharmann (1993) believes that students need to discuss their beliefs about creation origins and evolution and give reasons why each of the arguments is compelling. This enhances participation and during the process students often come to realize that they are not required to make an "either/or" choice between scientific theories and religion. Students in Scharmann's 1990 study expressed feelings of relief when they found that they were not alone in their confusion.

Conclusion

The present curricula for both high school and college biology courses does not allow students enough time nor sufficient varied experiences to process the complex and voluminous information being presented. For many, it is simply overwhelming academically, emotionally, and spiritually. By adding to the body of knowledge which specifically describes the difficulties experienced by students, instructional strategies can be developed and tested which hold promise in assisting students as they confront whether they should believe the teachings of the creationists or whether they should

accept the evidences presented by evolutionary theory. Science and religion both seek to answer human questions, but from entirely different epistemological bases (Scott & Cole, 1985). There appears to be a forced dichotomy between religion and evolutionary theory for many students. They believe that if they accept theistic creation, they must reject evolutionary theory. Deciding which realm is best suited to answer questions about the origin and development of life on earth presents an enigma to many students. "For most it is a lonely and personal thing" (Stokes, 1989, p. 24).

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Table 1

Questionnaire Items Pertaining to Understanding of Scientific Theory and the Theory of Evolution

Question	Response	
	Pretest	Posttest
1. Which of the following is the best definition for a scientific theory?		
*a. a belief that something is true based upon a large amount of supporting evidence	69.7%	66.5%
b. a law or principle that has been proven to be true	14.7%	17.4%
c. an educated guess that something is true	10.1%	10.6%
d. an idea which has limited evidence or support.	5.5%	5.5%
2. Which of the following would best describe the theory of evolution?		
a. Life on earth is constant and unchanging	4.2%	3.7%
b. life on earth has changed in the past but is now constant and unchanging	0%	3.7%
*c. life on earth has changed, is presently changing, and is predicted to continue changing in the future	89.4%	87.6%
d. life on earth has changed in the past but is not likely to change in the future because of human intervention.	6.4%	5.0%
3. Which of the following best explains changes in species over time?		
a. organs and structures which are not needed are lost	6.5%	6.5%
b. organisms can adapt in order to survive	47.9%	45.6%
*c. DNA changes which allow certain organisms to compete more successfully	18.0%	28.1%
d. some organisms run out of food and die, which others survive because they migrate to new territories	8.9%	12.9%
e. I do not know.	18.9%	6.9%

4. Which of the following best describes Darwin's *Theory of Survival of the Fittest*?

a. organisms must adapt in order to survive	44.7%	38.1%
b. only healthy organisms live to reproduce fertile offspring	3.7%	7.8%
c. only physically strong organisms live to reproduce fertile offspring	18.0%	13.3%
*d. the most competitive organisms survive long enough to reproduce fertile offspring	21.2%	33.9%
e. I do not know.	12.4%	6.9%

5. Charles Darwin is best remembered for:

a. saying that humans evolved from the apes	26.7%	11.5%
*b. his *Theory of Natural Selection*	49.8%	78.3%
c. his work with garden peas	3.2%	5.1%
d. describing DNA as the agent of heredity	7.4%	2.3%
e. I do not know.	12.9%	2.8%

** Indicates the correct response*

Table 2

Questionnaire Items Pertaining to Strongest and Weakest Evidences of Evolutionary Theory

Question	Response	
	Pretest	Posttest
6. Which do you feel is the strongest scientific evidence which supports evolutionary theory?		
a. fossils of species that are now extinct	29.0%	35.5%
b. variations in organisms that are alive today (e.g., races of humans, breeds of dogs, etc.)	13.4%	22.1%
c. homologous structures (e.g., bird's wing and human's arm)	8.3%	7.8%
d. biochemical similarities between species	3.7%	3.2%
e. embryological similarities between species	6.0%	5.5%
f. genetic similarities between species	12.0%	7.4%
g. other (please describe)	4.1%	2.8%
h. none of the above evidences are strong	7.8%	3.2%
i. I do not know enough about this topic to respond.	15.7%	12.5%
7. Which do you feel is the weakest argument scientists give to support evolutionary theory?		
a. life orginated from a simple type of cell	28.8%	37.0%
b. fossils of extinct organisms	9.3%	10.2%
c. complex organisms such as humans evolved from simpler species	22.3%	16.7%
d. other (please desribe)	1.9%	1.9%
e. none of the above arguments are weak	24.7%	24.1%
f. I do not know enough about his topic to respond.	13.0%	10.1%

Table 3

Questionnaire Items Pertaining to Religion and Evolutionary Theory

Question	Response	
	Pretest	Posttest
8. Which of the following best describes your opinion about how the scientific theory of evolution and your religious beliefs are related?		
a. I feel there is no disagreement between the two	12.5%	19.9%
b. I feel they are somewhat in disagreement	23.0%	34.3%
c. I feel they disagee	45.6%	29.6%
d. I am not sure whether they agree or disagree	18.9%	16.2%
9. Do you feel that a person can accept the validity of the theory of evolution and also believe in God? Please explain your response.		
a. Yes	74.0%	74.0%
b. No.	26.0%	26.0%
10. Does anything concern or trouble you about the scientific theory of evolution? Please explain your response.		
a. Yes	35.0%	25.0%
b. No.	65.0%	75.0%

Table 4

Questionnaire Items Pertaining to Changes in Thinking and Suggestions for Biology Professors

Question	Response	
	Pretest	Posttest
11. When presented with new scientific ideas, which of the following would influence you the most?		
a. sound evidence that the new ideas have objective or scientific support	68.4%	74.8%
b. peers talk with me about their beliefs concerning the ideas	3.8%	5.5%
c. family members talk with me about their beliefs concerning the ideas	4.6%	3.2%
d. the teacher presenting the ideas accepts them as valid	15.3%	9.2%
e. other respected individuals talk with me about their beliefs concerning the ideas.	7.9%	7.3%
12. How open minded to scientific ideas do you consider yourself?		
a. very open-minded	38.5%	43.1%
b. somewhat open-minded	56.0%	51.4%
c. I will not accept ideas if they conflict with my present beliefs.	5.5%	5.5%
13. Has studying the scientific theory of evolution changed your thinking about the subject? Please explain your response.		
a. Yes		77.6%
b. No		22.4%
14. Are there suggestions you could make to your biology professor concerning how he/she could have assisted you in gaining a more complete understanding of the scientific theory of evolution? If your answer is yes, please be as specific as possible in making your suggestions.		
a. Yes		16.1%
b. No		83.9%